Selecting management practices and cover crops for reducing tillage, enhancing soil quality, and managing weeds in western WA organic vegetable farms.

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Introduction

Grower interest in reduced tillage techniques stems from concern over soil quality and energy use. Tillage decimates large-bodied soil organisms, reduces soil carbon storage and weakens the stability of aggregates. Yet, organic vegetable growers in the Pacific Northwest currently pass over their fields 10 to 20 times annually to incorporate cover crops and amendments, prepare the soil for planting, and manage weeds.

Incorporating reduced tillage into organic vegetable cropping systems requires careful integration of cover crops and specific implements. Cover crops for reduced tillage systems must survive winter, produce sufficient biomass to smother weeds, mature early, and preferably add nitrogen to the system. Tools must effectively kill the cover crop without tillage and also prepare the soil to receive a transplant or seed. Our goal is to increase organic farmer economic and environmental sustainability through soil conservation and reduced tillage.

Objectives

- **Identify production methods that effectively integrate cover crops and reduced tillage technologies to improve soil quality while reducing in-season weed pressure and seed bank populations.**
- **Select cover crops and termination strategies for reduced tillage organic agriculture.**
- **Evaluate profitability and greenhouse gas impacts of reduced tillage cropping systems on these farms.**
- **Assist western Washington organic producers to adopt reduced tillage techniques on their farms.**

Experimental Design

Squa	Broc	Bns	Broc	Squa	Bns	Broc	Bns	Squa	Squa	Broc	Bns	Squa	Broc	Bns
flailing + no-till			flailing + strip till			flailing + complete till			roll/crimp + strip till			roll/crimp + no-till.		

Grain (cover crop) → Beans (cash crop) → Vetch (cover crop) → Broccoli (cash crop) → Grain (cover crop) → Squash (cash crop)

Figure 1. One of four replicates (top) and rotation scheme (bottom) in the WSU Puyallup Long-term Organic Reduced Tillage Systems Experiment. Squa=squash; Broc= broccoli; Bns = beans.

In fall 2011, we initiated a long-term organic reduced tillage cropping systems experiment with three cash crops in rotation and adaptive management to incorporate new cover crops and equipment improvements. The trial has 4 replications and 5 reduced tillage systems (Figure 1) that vary ground preparation (Figure 2), and cover crop termination (Figure 3), and include: i) flailing+no-till, ii) flailing+strip till, iii) flailing+spader iv) roll/crimp+strip till, v) roll/crimp+no-till.

Figure 2. Reduced tillage plots were prepared for transplanting with a Yetter Strip Tiller (a) or with a custom "planting aid" tool (b) that leaves a 5 cm wide by 10 cm deep swath (c).

Selecting Cover Crops and Termination Strategies

Cover crop varieties for the long-term systems experiment were selected in part based on trials conducted in 2012 and 2013 at WSU Puyallup (Figure 3). Cover crops were planted in fall and then their phenological development, biomass, and ability to be terminated with a flail mower and roller/crimper was monitored during the following spring and summer.

Figure 3. Grain and vetch cover crops were trialed in a variety trial (a) adjacent to the reduced tillage systems trial. Cover crops in both trials were terminated with an I&J Roller/Crimper (b) or with either an International Harvester flail mower (c) or John Deere flail mower (not pictured). Aroostook rye prior to termination (d).

Key Findings

- Barley matured more quickly than rye. Barley completed anthesis (Zadok's 70) around May 16, 'Aroostook' rye around May 21, and common rye around June 5 (Figure 4a).
- Because rye matures less rapidly during the critical stages of termination (late anthesis to early milk, Zadok's 68-73), it was easier to manage termination at the desired time than barley.
- Common' vetch (*Vicia sativa*) matured more quickly than 'Purple bounty', 'Lana', and hairy vetch (*Vicia villosa*) (Figure 4b).
- 'Purple bounty' and 'Hairy' vetch were the slowest maturing of the vetches and did not reach full flowering (Mischler scale 5-6) until mid June 20. 'Common' vetch reached full flowering around May 24. 'Lana' was slower maturing and reached full flower around June 1.
- Based on the variety trial, 'Aroostook' rye and 'Lana' vetch were included as cover crops in the reduced tillage cropping systems rotation in fall 2012 (Figure 1).

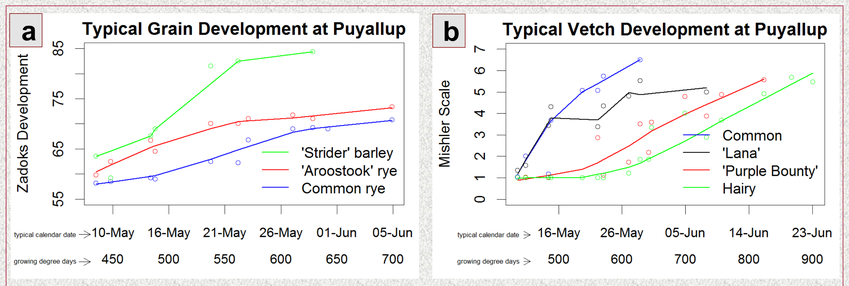

Figure 4. Grain (a) and vetch (b) development May-June 2012 and 2013 using Zadok's development scale for grains and Mischler et al. (2010) scale for vetch, in relation to cumulative growing degree days (base temperature = 4 C). Typical calendar date is based on average growing degree days data from 2005-2014. Zadok's stages are: 50-60 inflorescence emergence, 60-70 anthesis, 70-80 milk development. Vetch stages are: 4=60% flowering, 5=80% flowering, 6= 100% flowering, 7= early pod development. (Mischler, R, S Duiker, W. Curran, and D. Wilson. 2010. Hairy vetch management for no-till organic corn production. Agronomy Journal, 102: 355-362)

Crop Yield

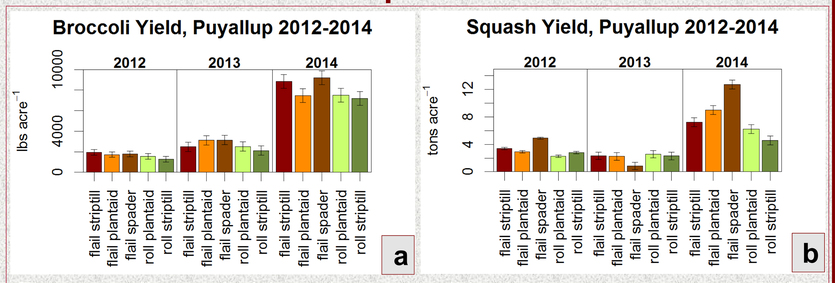

Figure 5. Broccoli (a) and squash (b) yield by treatment at WSU Puyallup in 2012-2014. Treatment was not significant for broccoli and was significant for squash in 2012 and 2014 (p<0.0001). Bars are SE.

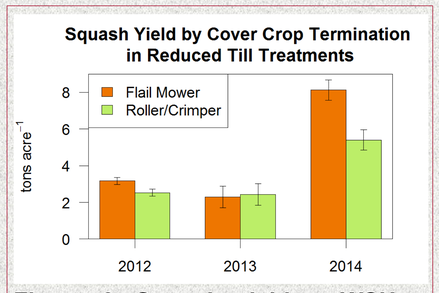

Figure 6. Squash yield at WSU Puyallup by cover crop termination method within reduced tillage treatments in 2012-2014. Termination method was significant in 2012 and 2014 (p=0.008, p<0.001). Bars are SE.

Key Findings

- Cover crop termination and reduced tillage combinations did not effect broccoli yields during any of the 3 years of the trial (Figure 5a).
- Full tillage (flail spader) bore greater squash yields than reduced tillage treatments in both 2012 and 2014 (Figure 5b).
- Flail mowing produced greater squash yields in 2012 and 2014, among reduced tillage treatments (Figure 6).
- Strip tilling yielded more squash in 2012, but plant aid yielded more in 2014 (data not shown).

Reduced Tillage Broccoli On-Farm Trial

Key Findings

- Strip tilling following flail mowing common vetch produced broccoli yields equivalent to rototilling at Kirsop Farm (Figures 7 & 8), though hand weeding took longer.
- Grower experiments with high-residue cultivation were promising and will be explored further.

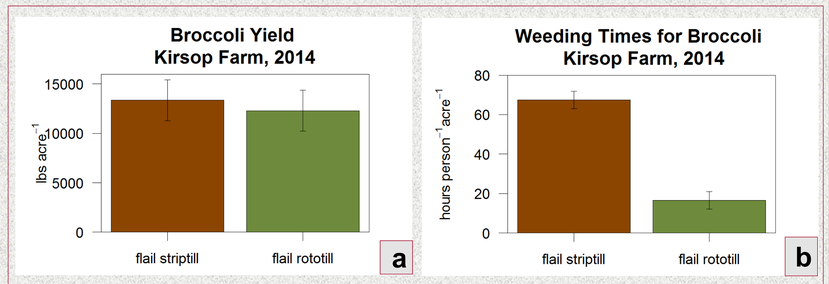

Figure 7. Broccoli yield (a) and time spent weeding (b) at Kirsop Farm, 2014. Yields were not significantly different (p value = 0.70, n=4) but hand weeding was (p value =0.002, n=4). Bars are SE.

Figure 8. Common vetch was terminated with a flail mower to produce mulch (a) for a reduced tillage organic broccoli trial (b) at Kirsop Farm, Tumwater, WA, 2014. Strip till (left) and rototill (right).

This research was supported by a grant from the Western Sustainable Agriculture Research and Education Program and a seed grant from WSU's Biologically Intensive and Organic Agriculture Program